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DATE: Wednesday, December 07, 2005

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☐	L3	L2 and heat exchanger$1	11
☐	L2	L1 and (synthesis gas or syngas or hydrogen near1 carbon monoxide)	12
☐	L1	microreactor same microchannel$1 and fischer tropsch	21

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                                                       ENTRY    SESSION
FULL ESTIMATED COST                                     0.06       0.27

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FULL ESTIMATED COST                                     0.21       0.48

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=> s microreactor and microchannel
          3337 MICROREACTOR
          1803 MICROREACTORS
          4080 MICROREACTOR
                 (MICROREACTOR OR MICROREACTORS)
          4753 MICROCHANNEL
          2264 MICROCHANNELS
          5866 MICROCHANNEL
                 (MICROCHANNEL OR MICROCHANNELS)
L1         284 MICROREACTOR AND MICROCHANNEL

=> s l1 and fischer tropsch
         23202 FISCHER
            15 FISCHERS
         23214 FISCHER
                 (FISCHER OR FISCHERS)
          7791 TROPSCH
          7690 FISCHER TROPSCH
                 (FISCHER(W)TROPSCH)
L2           9 L1 AND FISCHER TROPSCH
```

=> d l2 ibib ab 1-9

L2 ANSWER 1 OF 9 CAPLUS COPYRIGHT 2005 ACS on STN
ACCESSION NUMBER: 2005:735342 CAPLUS
DOCUMENT NUMBER: 143:195591
TITLE: Process for conducting an equilibrium limited chemical reaction using **microchannel** technology
INVENTOR(S): Tonkovich, Anna Lee; Paul, Jarosch Kai Tod; Mazanec, Terry; Daly, Francis P.; Taha, Rachid; De Alba, Enrique Aceves
PATENT ASSIGNEE(S): USA
SOURCE: U.S. Pat. Appl. Publ., 33 pp.
CODEN: USXXCO
DOCUMENT TYPE: Patent
LANGUAGE: English
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
US 2005176832	A1	20050811	US 2004-777033	20040211
WO 2005082519	A1	20050909	WO 2005-US623	20050107

W: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW
RW: BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW, AM, AZ, BY, KG, KZ, MD, RU, TJ, TM, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG

PRIORITY APPLN. INFO.: US 2004-777033 A 20040211
AB The invention relates to a process for conducting an equilibrium limited chemical reaction in a **microchannel** reactor. The process involves the use of active heat exchange and is suitable for conducting exothermic and endothermic reactions. The process comprises: (A) determining the equilibrium conversion value for the primary reactant in the reactant composition at the first reaction temperature and at another reaction temperature; (B) passing the reaction composition through a first reaction zone in the reactor at the first reaction temperature in contact with a first catalyst to form an intermediate product composition so that the approach to conversion of the primary reactant is ≥5%; and (C) passing the intermediate product composition into another reaction zone in contact with another catalyst to form the desired product so that the approach to conversion conversion of the primary reactant is ≥5%. The process is particularly suitable for synthesizing methanol and di-Me ether.

L2 ANSWER 2 OF 9 CAPLUS COPYRIGHT 2005 ACS on STN
ACCESSION NUMBER: 2005:538848 CAPLUS
DOCUMENT NUMBER: 143:45768
TITLE: **Microreactors** for Syngas Conversion to Higher Alkanes: Characterization of Sol-Gel-Encapsulated Nanoscale Fe-Co Catalysts in the **Microchannels**
AUTHOR(S): Nagineni, Venkata S.; Zhao, Shihuai; Potluri, Avinash; Liang, Yu; Siriwardane, Upali; Seetala, Naidu V.; Fang, Ji; Palmer, James; Kuila, Debasish
CORPORATE SOURCE: Institute for Micromanufacturing (IfM), Louisiana Tech University, Ruston, LA, 71272, USA
SOURCE: Industrial & Engineering Chemistry Research (2005),

44(15), 5602-5607
CODEN: IECRED; ISSN: 0888-5885
PUBLISHER: American Chemical Society
DOCUMENT TYPE: Journal
LANGUAGE: English
AB Silicon **microreactors** were coated with mixed-metal Fe-Co **Fischer-Tropsch** catalysts in alumina sol-gel for conversion of syngas (CO + H2) to higher alkanes. Characterization of the nanocatalysts using SEM, energy-dispersive x-ray, atomic force microscopy, and Brunauer-Emmett-Teller surface area measurements, packaging, and the reaction results from a mass spectrometer at controlled temps. (200-260°) and pressure (1 atm) with varying H2:CO ratios from 1:1 to 10:1 are described. The catalyst does not adequately infiltrate the 5-μm channels; it coats nicely the 25-μm channels. The initial results are consistent with a lower conversion of CO (.apprx.32%) in a 5-μm-channel reactor and a higher conversion (.apprx.52%) in a 25-μm-channel reactor. The selectivity to propane (.apprx.80%) is not affected by the width of the **microchannels**. The activity of the sol-gel-encapsulated catalyst before and after the reactions is estimated from its magnetic properties using a vibrating sample magnetometer.
REFERENCE COUNT: 40 THERE ARE 40 CITED REFERENCES AVAILABLE FOR THIS RECORD. ALL CITATIONS AVAILABLE IN THE RE FORMAT

L2 ANSWER 3 OF 9 CAPLUS COPYRIGHT 2005 ACS on STN
ACCESSION NUMBER: 2005:213556 CAPLUS
DOCUMENT NUMBER: 143:268670
TITLE: Microprocess technology for **Fischer-Tropsch** gas-to-liquids
AUTHOR(S): Wang, Yong; Hu, J.; Cao, C.; Mazanec, T. J.
CORPORATE SOURCE: Pacific Northwest National Laboratory, Richland, WA, 99352, USA
SOURCE: Preprints - American Chemical Society, Division of Petroleum Chemistry (2005), 50(1), 69-70
CODEN: ACPCAT; ISSN: 0569-3799
PUBLISHER: American Chemical Society, Division of Petroleum Chemistry
DOCUMENT TYPE: Journal
LANGUAGE: English
AB Structured Co based-engineered catalysts exhibited high activity in **Fischer-Tropsch** synthesis, especially when integrated with a **microchannel** reactor, due to improved heat and mass transfer. Higher CO conversion with lower methane selectivity was achieved even under unfavorable reaction conditions in conventional **Fischer-Tropsch** synthesis. With the use of the engineered catalyst in the **microchannel** reactor, it was possible to operate **Fischer-Tropsch** synthesis at temps. much higher than those at which conventional packed bed or slurry reactors are operated while the reaction is still controlled in the nearly isothermal regime. Therefore, the productivity can be enhanced by a factor of three to twelve in comparison with conventional **Fischer-Tropsch** reactors. The unique **microchannel** reactor design and its integration with engineered catalyst allow operation of the **Fischer-Tropsch** reaction under a wide temperature range and flexibility to obtain different products.
REFERENCE COUNT: 1 THERE ARE 1 CITED REFERENCES AVAILABLE FOR THIS RECORD. ALL CITATIONS AVAILABLE IN THE RE FORMAT

L2 ANSWER 4 OF 9 CAPLUS COPYRIGHT 2005 ACS on STN
ACCESSION NUMBER: 2004:331557 CAPLUS
DOCUMENT NUMBER: 140:341237
TITLE: Catalysts, in **microchannel** apparatus, concentration gradients, and reactions using same
INVENTOR(S): Manzanec, Terry J.; Wang, Yong; Silva, Laura J.; Vander Wiel, David P.

PATENT ASSIGNEE(S): USA
SOURCE: U.S. Pat. Appl. Publ., 22 pp.
CODEN: USXXCO
DOCUMENT TYPE: Patent
LANGUAGE: English
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
US 2004076562	A1	20040422	US 2002-279089	20021022
CA 2503194	AA	20040506	CA 2003-2503194	20031017
WO 2004037418	A2	20040506	WO 2003-US33104	20031017
WO 2004037418	A3	20040916		
W: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW				
RW: GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW, AM, AZ, BY, KG, KZ, MD, RU, TJ, TM, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG				
EP 1556165	A2	20050727	EP 2003-809579	20031017
R: AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LI, LU, NL, SE, MC, PT, IE, SI, LT, LV, FI, RO, MK, CY, AL, TR, BG, CZ, EE, HU, SK				

PRIORITY APPLN. INFO.: US 2002-279089 A 20021022
WO 2003-US33104 W 20031017

AB The present invention provides new **microreactor** systems, catalysts, and chemical processes. Methods of making novel catalysts and reaction apparatus are also described.

L2 ANSWER 5 OF 9 CAPLUS COPYRIGHT 2005 ACS on STN
ACCESSION NUMBER: 2004:224074 CAPLUS
TITLE: **Microreactors** for catalysis using nano-catalysts
AUTHOR(S): Kuila, Debasish; Zhao, Shihuai; Nagineni, Venkata S.; Potluri, Avinash; Indukuri, H.; Liang, Yu; Cao, W.; Hu, J.; Fang, Ji; Varahramyan, K.; Nassar, Raja; Palmer, James; Siriwardane, Upali; Naidu, Seetala V.
CORPORATE SOURCE: Institute for Micromanufacturing/Chemistry, Louisiana Tech University, Ruston, LA, 71272, USA
SOURCE: Abstracts of Papers, 227th ACS National Meeting, Anaheim, CA, United States, March 28-April 1, 2004 (2004), COLL-473. American Chemical Society: Washington, D. C.
CODEN: 69FGKM
DOCUMENT TYPE: Conference; Meeting Abstract
LANGUAGE: English

AB **Microchannel microreactors** based on Si (5-100 μ) have been used to study heterogeneous catalysis of three significant reactions: hydrogenation and dehydrogenation of cyclohexene, preferential oxidation for CO amelioration in feed for Proton Exchange Membrane (PEM) based fuel cells and **Fischer-Tropsch** synthesis to higher alkane fuels. For the prototype reaction, a 95 % conversion of cyclohexene has been achieved with sputtered and sol-gel coated platinum catalyst. Conversion of synthesis gas (CO:H2) to higher alkanes (.apprx. 75% with a selectivity to propane of 80%) and carbon monoxide to carbon dioxide (.apprx. 90% conversion with a selectivity of 90% to CO2) to process the feed gas have also been quite successful. The nano-catalysts for these processes have been characterized using SEM, EDX, AFM, VSM and BET surface area measurements. A parallel-array of reactors has been developed for multiple reaction studies and catalyst screening. Design of

expts. for these reactions will be presented.

L2 ANSWER 6 OF 9 CAPLUS COPYRIGHT 2005 ACS on STN
ACCESSION NUMBER: 2004:89738 CAPLUS
DOCUMENT NUMBER: 141:108227
TITLE: Nanoscale platinum and iron-cobalt catalysts deposited in **microchannel microreactors** for use in hydrogenation and dehydrogenation of cyclohexene, selective oxidation of carbon monoxide and **fischer-tropsch** process to higher alkanes
AUTHOR(S): Zhao, Shihuai
CORPORATE SOURCE: Louisiana Tech. Univ., Ruston, LA, USA
SOURCE: (2003) 142 pp. Avail.: UMI, Order No. DA3084550 From: Diss. Abstr. Int., B 2003, 64(3), 1376
DOCUMENT TYPE: Dissertation
LANGUAGE: English
AB Unavailable

L2 ANSWER 7 OF 9 CAPLUS COPYRIGHT 2005 ACS on STN
ACCESSION NUMBER: 2003:930877 CAPLUS
DOCUMENT NUMBER: 139:397276
TITLE: Reactors with varying cross-section and their manufacture for reactions conducted under varying local contact time
INVENTOR(S): Wang, Yong; Cao, Chunshe; Kimble, James B.; Silva, Laura J.
PATENT ASSIGNEE(S): USA
SOURCE: U.S. Pat. Appl. Publ., 13 pp.
CODEN: USXXCO
DOCUMENT TYPE: Patent
LANGUAGE: English
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
US 2003219903	A1	20031127	US 2002-153577	20020521
CA 2486379	AA	20031204	CA 2003-2486379	20030521
WO 2003099429	A1	20031204	WO 2003-US16189	20030521
W: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW				
RW: GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW, AM, AZ, BY, KG, KZ, MD, RU, TJ, TM, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG				
EP 1511561	A1	20050309	EP 2003-755442	20030521
R: AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LI, LU, NL, SE, MC, PT, IE, SI, LT, LV, FI, RO, MK, CY, AL, TR, BG, CZ, EE, HU, SK				

PRIORITY APPLN. INFO.: US 2002-153577 A 20020521
WO 2003-US16189 W 20030521

AB Chemical reactions are conducted in a reaction **microchannel** that has a varying cross-sectional area such that a chemical reactant or reactants experience varying local contact time as the reactant(s) flow through the channel. The reactors have multiple reaction **microchannels** with varying cross-sectional areas. The reaction channel section has a trapezoidal shape that becomes broader from the inlet toward the outlet.

L2 ANSWER 8 OF 9 CAPLUS COPYRIGHT 2005 ACS on STN
ACCESSION NUMBER: 2003:632804 CAPLUS

TITLE: **Microreactors** for catalysis
AUTHOR(S): Kuila, D.; Nagineni, Venkata S.; Potluri, Avinash; Zhao, Shihuai; Aithal, Rajendra K.; Liang, Yu; Fang, Ji; Nassar, Raja; Siriwardane, Upali; Naidu, Seetala V.; Palmer, James
CORPORATE SOURCE: Institute for Micromanufacturing/Chemistry, Louisiana Tech University, Ruston, LA, 71272, USA
SOURCE: Abstracts of Papers, 226th ACS National Meeting, New York, NY, United States, September 7-11, 2003 (2003), INOR-022. American Chemical Society: Washington, D. C.
CODEN: 69EKY9
DOCUMENT TYPE: Conference; Meeting Abstract
LANGUAGE: English
AB **Microreactors** provide distinct advantages to energy related projects on fuel cells and, in general, on production and processing of fuels. The first advantage of **microreactors** is the small phys. size of the overall device that allows rapid heat and mass transfer in contrast to conventional reactors. The second advantage is indeed one of the major thrusts of our research: the creation of parallel-array based reactors for rapid catalyst screening. The small catalyst and reactant requirements and fast thermal cycling yield an ideal environment for process development as evidenced by UOP joining the growing number of major companies conducting **microreactor** research. **Microreactors** provide the necessary link between the highly combinatorial titer plate approaches that provide no kinetic information and the detailed but time consuming industrial pilot scale packed bed reactors. Our current projects, supported by NSF-EPSCoR and DOE, are addressing the development and characterization of nano-scale metal catalysts using various technologies for conversion of synthesis gas to higher alkane fuels (**Fischer-Tropsch** process) that is not achievable using conventional fixed bed reactors due to the reaction's high exothermicity. The synthesis of higher alkanes using nano-catalysts of Fe/Co and their fabrication in the **microchannels** using sol-gel support and their characterization by techniques such as XPS, SEM, EDX, AFM, vibrating sample magnetometer (VSM) and surface area measurement (BET method) will be described. Our progress on modeling of this reaction to optimize the yield and selectivity will also be presented.

L2 ANSWER 9 OF 9 CAPLUS COPYRIGHT 2005 ACS on STN
ACCESSION NUMBER: 2003:630222 CAPLUS
TITLE: **Microchannel** catalytic process for converting biomass derived syngas to transportation fuels
AUTHOR(S): Cao, Chunshe; Wang, Yong; Elliott, Douglas C.; Hu, John; Stevens, Don
CORPORATE SOURCE: Pacific Northwest National Laboratory, Richland, WA, 99352, USA
SOURCE: Abstracts of Papers, 226th ACS National Meeting, New York, NY, United States, September 7-11, 2003 (2003), CATL-013. American Chemical Society: Washington, D. C.
CODEN: 69EKY9
DOCUMENT TYPE: Conference; Meeting Abstract
LANGUAGE: English
AB Biomass gasification process provides feedstock for **Fischer-Tropsch** synthesis to produce liquid transportation fuels and chems. Compared to the conventional petroleum/natural gas based GTL technol., biomass-derived feedstock has the nature of small scale, and the use of **microchannel** reactor technol. is potentially cost-competitive. Battelle/PNNL has developed a catalytic **microchannel** reactor integrated with highly efficient heat exchanger to provide isothermal environment for the strongly exothermic FT synthesis reactions. It allows the process be operated close to the kinetically controlled regime so that

the heat and mass transfer limitation be minimized in this three phase reaction system. In order to achieve high yield of naphtha and diesel range of hydrocarbons (C5-C19), we have developed a unique structured catalyst system suitable for the deployment in **microchannel** reactor applications. This engineered catalyst structures are based on metallic monolith supports and uniformly coated with improved catalyst formulation. The objective was to take advantage of the high thermal conductivity and reduced mass transfer resistance in an ordered structure. It has been demonstrated that this engineered catalyst produces much narrower carbon distributions (mainly less than C25) than a conventional powder catalyst with the similar productivity and methane selectivity. In particular, majority of the synthesis products fall in to the slates of gasoline and diesel range. This unique product distribution, in turn, has a pos. impact on process economics since there is a strong possibility to eliminate a hydrocracker in downstream processing. In addnl. to the exptl. work, the finite element method (FEM) modeling that efficiently solves the reacting transport problems in complex geometries has been used to optimize the reactor and catalyst design. Numerical simulation in predicting the temperature and conversion profiles in the **microreactor** helps to design the reactor channel geometries. And the simulation of component concentration profile assists to tailor the coating thickness of structured catalyst in order to evaluate the diffusion effects on product selectivity. This optimization improves the performance of monolithic catalysts integrated with **microchannel** reactors for biomass-derived syngas conversion to fuels.

Hit List

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☐ 1. Document ID: US 20050239910 A1

Using default format because multiple data bases are involved.

L3: Entry 1 of 11 File: PGPB Oct 27, 2005

PGPUB-DOCUMENT-NUMBER: 20050239910
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050239910 A1

TITLE: Fluidization and solids processing in microchannel devices

PUBLICATION-DATE: October 27, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Jarosch, Kai	Bexley	OH	US
Tonkovich, Anna Lee	Marysville	OH	US
Hesse, David J.	Columbus	OH	US
Daymo, Eric	Marysville	OH	US
Perry, Steven T.	Galloway	OH	US
Silva, Laura J.	Dublin	OH	US

US-CL-CURRENT: 518/726

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Drawing D...

☐ 2. Document ID: US 20050009175 A1

L3: Entry 2 of 11 File: PGPB Jan 13, 2005

PGPUB-DOCUMENT-NUMBER: 20050009175
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050009175 A1

TITLE: Chemical processing microsystems comprising high-temperature parallel flow microreactors

PUBLICATION-DATE: January 13, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Bergh, H. Sam	Santa Clara	CA	US

Guan, Shenheng Santa Clara CA US

ASSIGNEE-INFORMATION:

NAME	CITY	STATE	COUNTRY	TYPE CODE
Symyx Technologies, Inc.				02

APPL-NO: 10/913049 [PALM]
DATE FILED: August 5, 2004

RELATED-US-APPL-DATA:
child 10913049 A1 20040805
parent continuation-of 09728732 20001128 US PENDING
child 09728732 20001128 US
parent division-of 09518794 20000303 US GRANTED
parent-patent 6749814 US
non-provisional-of-provisional 60122704 19990303 US

INT-CL: [07] C12 M 1/34

US-CL-PUBLISHED: 435/287.2
US-CL-CURRENT: 435/287.2

REPRESENTATIVE-FIGURES: NONE

ABSTRACT:

A chemical processing microsystem useful for identifying and optimizing materials (e.g., catalysts) that enhance chemical processes or for characterizing and/or optimizing chemical processes is disclosed. The chemical processing microsystem comprises a plurality of microreactors 600 and, in a preferred embodiment, a plurality of microseparators 900 integral with the chemical processing microsystem 10. The microreactors 600 are preferably diffusion-mixed microreactors formed in a plurality of laminae that include a modular, interchangeable candidate-material array 100. The material array 100 comprises a plurality of different candidate materials (e.g., catalysts), preferably arranged at separate, individually addressable portions of a substrate (e.g., wafer). The microseparators 900 are similarly formed in a plurality of laminae that include a modular, interchangeable adsorbent array 700. The adsorbent array 700 comprises one or more adsorbents, preferably arranged at separate, individually addressable portions of a substrate to spatially correspond to the plurality of different candidate materials. Modular microfluidic distribution systems are also disclosed. The chemical processing microsystem can be integrated into a material evaluation system that enables a comprehensive combinatorial material science research program.

[0001] This application claims priority to commonly owned, co-pending U.S. patent application Ser. No. 60/122,704 filed Mar. 3, 1999 entitled "Chemical Processing Microsystems, Diffusion-Mixed Microreactors and Methods for Preparing and Using Same", which is hereby incorporated by reference for all purposes.

☐ 3. Document ID: US 20040033455 A1

L3: Entry 3 of 11 File: PGPB Feb 19, 2004

PGPUB-DOCUMENT-NUMBER: 20040033455
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040033455 A1

TITLE: Integrated combustion reactors and methods of conducting simultaneous endothermic and exothermic reactions

PUBLICATION-DATE: February 19, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Tonkovich, Anna Lee	Marysville	OH	US
Roberts, Gary	West Richland	WA	US
Fitzgerald, Sean P.	Columbus	OH	US
Neagle, Paul W.	Westerville	OH	US
Qiu, Dongming	Dublin	OH	US
Schmidt, Matthew B.	Columbus	OH	US
Perry, Steven T.	Galloway	OH	US
Hesse, David J.	Columbus	OH	US
Luzenski, Robert J.	Marysville	OH	US
Chadwell, G. Bradley	Reynoldsburg	OH	US
Peng, Ying	Columbus	OH	US
Mathias, James A.	Columbus	OH	US
Gano, Nathan P.	Dublin	OH	US
Long, Richard Q.	Columbus	OH	US
Roger, Wm. Allen	Marysville	OH	US
Arora, Ravi	Dublin	OH	US
Simmons, Wayne W.	Dublin	OH	US
Yang, Barry L.	Dublin	OH	US
Kuhlmann, David J.	Powell	OH	US
Wang, Yong	Richland	WA	US
Yuschak, Thomas D.	Dublin	OH	US
Forte, Thomas	Columbus	OH	US
Monahan, John Arthur	Westerville	OH	US
Jetter, Robert	Pebble Beach	CA	US

APPL-NO: 10/222196 [PALM]
DATE FILED: August 15, 2002

INT-CL: [07] F23 D 3/40

US-CL-PUBLISHED: 431/7; 431/10, 431/326, 431/170
US-CL-CURRENT: 431/7; 431/10, 431/170, 431/326

REPRESENTATIVE-FIGURES: 1

ABSTRACT:

Integrated Combustion Reactors (ICRS) and methods of making ICRs are described in

which combustion chambers (or channels) are in direct thermal contact to reaction chambers for an endothermic reaction. Particular reactor designs are also described. Processes of conducting reactions in integrated combustion reactors are described and results presented. Some of these processes are characterized by unexpected and superior results, and/or results that can not be achieved with any prior art devices.

OTHER APPLICATIONS

[0001] The invention may be further understood by reference to U.S. patent applications Ser. Nos. _____ (Title: Multistream Microchannel Device; Attorney Docket No. 02-001), _____ (Title: Process for Cooling a Product in a Heat Exchanger Employing Microchannels for the Flow of Refrigerant and Product, Attorney Docket No. 01-002), and _____ (Title Process for Conducting an Equilibrium Limited Chemical Reaction in a Single Stage Process Channel; Attorney Docket No. 02-051), all of which were filed on Aug. 15, 2002, all of which are incorporated herein by reference.

☑ 4. Document ID: US 20040031592 A1

L3: Entry 4 of 11 File: PGPB Feb 19, 2004

PGPUB-DOCUMENT-NUMBER: 20040031592
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040031592 A1

TITLE: Multi-stream microchannel device

PUBLICATION-DATE: February 19, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Mathias, James Allen	Columbus	OH	US
Chadwell, G. Bradley	Reynoldsburg	OH	US
Qiu, Dongming	Dublin	OH	US
Tonkovich, Anna Lee Y.	Marysville	OH	US
Perry, Steven T.	Galloway	OH	US
Schmidt, Matthew B.	Columbus	OH	US

APPL-NO: 10/222604 [PALM]
DATE FILED: August 15, 2002

INT-CL: [07] F28 D 15/00

US-CL-PUBLISHED: 165/104.19
US-CL-CURRENT: 165/104.19

REPRESENTATIVE-FIGURES: 1A

ABSTRACT:

The invention is a process and device for exchanging heat energy between three or more streams in a microchannel heat exchanger which can be integrated with a microchannel reactor to form an integrated microchannel processing unit. The invention enables the combining of a plurality of integrated microchannel devices to provide the benefits of large-scale operation. In particular, the microchannel heat exchanger of the present invention enables flexible heat transfer between multiple streams and total heat transfer rates of about 1 Watt or more per core unit volume expressed as W/cc.

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is related to the following commonly-assigned applications filed concurrently herewith on Aug. 15, 2002: "Integrated Combustion Reactors and Methods of Conducting Simultaneous Endothermic and Exothermic Reactions", Attorney Docket No. 02-052 and "Process for Cooling a Product in a Heat Exchanger Employing Microchannels for the Flow of Refrigerant and Product", Attorney Docket No. 01-002 which applications are incorporated herein by reference.

☐ 5. Document ID: US 20030072699 A1

L3: Entry 5 of 11 File: PGPB Apr 17, 2003

PGPUB-DOCUMENT-NUMBER: 20030072699
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030072699 A1

TITLE: Integrated reactors, methods of making same, and methods of conducting simultaneous exothermic and endothermic reactions

PUBLICATION-DATE: April 17, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Tonkovich, Anna Lee	Marysville	OH	US
Roberts, Gary	West Richland	WA	US
Perry, Steven T.	Galloway	OH	US
Fitzgerald, Sean P.	Columbus	OH	US

APPL-NO: 10/076875 [PALM]
DATE FILED: February 14, 2002

RELATED-US-APPL-DATA:
child 10076875 A1 20020214
parent continuation-in-part-of 09375614 19990817 US PENDING
child 10076875 A1 20020214
parent continuation-in-part-of 09640930 20000817 US GRANTED
parent-patent 6378278 US
non-provisional-of-provisional 60269628 20010216 US

INT-CL: [07] B01 J 8/02, B01 J 8/04

US-CL-PUBLISHED: 422/190; 422/188, 422/211, 422/240
US-CL-CURRENT: 422/190; 422/188, 422/211, 422/240

REPRESENTATIVE-FIGURES: NONE

ABSTRACT:

Integrated Combustion Reactors (ICRs) and methods of making ICRs are described in which combustion chambers (or channels) are in direct thermal contact to reaction chambers for an endothermic reaction. Superior results were achieved for combustion chambers which contained a gap for free flow through the chamber. Particular reactor designs are also described. Processes of conducting reactions in integrated combustion reactors are described and results presented. Some of these processes are characterized by unexpected and superior results.

RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. patent application Ser. Nos. 09/375,614 and 09/640,930, which are incorporated herein as if reproduced in full below. In accordance with 35 U.S.C. sect. 119(e), this application claims priority to U.S. Provisional Application No. 60/269,628, filed Feb. 16, 2001.

☐ 6. Document ID: US 6969506 B2

L3: Entry 6 of 11 File: USPT Nov 29, 2005

US-PAT-NO: 6969506
DOCUMENT-IDENTIFIER: US 6969506 B2

TITLE: Methods of conducting simultaneous exothermic and endothermic reactions

DATE-ISSUED: November 29, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Tonkovich; Anna Lee	Marysville	OH		
Roberts; Gary L.	West Richland	WA		
Perry; Steven T.	Galloway	OH		
Fitzgerald; Sean P.	Columbus	OH		

ASSIGNEE-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
Battelle Memorial Institute	Richland	WA			02

APPL-NO: 10/076875 [PALM]
DATE FILED: February 14, 2002

PARENT-CASE:
RELATED APPLICATIONS This application is a continuation-in-part of U.S. patent application Ser. No. 09/375,614 filed Aug. 17, 1999, now U.S. Pat. No. 6,488,838

and Ser. No. 09/640,903, filed Aug. 17, 2000 now U.S. Pat. No. 6,680,044, which are incorporated herein as if reproduced in full below. In accordance with 35 U.S.C. sect. 119(e), this application claims priority to U.S. Provisional Application No. 60/269,628, filed Feb. 16, 2001.

INT-CL: [07] C01 B 3/26

US-CL-ISSUED: 423/652; 252/373, 423/418.2, 423/656, 423/659
US-CL-CURRENT: 423/652; 252/373, 423/418.2, 423/656, 423/659

FIELD-OF-SEARCH: 252/373, 423/418.2, 423/652, 423/656, 423/659

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

PAT-NO	ISSUE-DATE	PATENTEE-NAME	US-CL
4795618	January 1989	Laumen	422/202
5047381	September 1991	Beebe	502/304
5270127	December 1993	Koga et al.	429/17
5366719	November 1994	van Wingerden et al.	423/659
5403184	April 1995	Hosaka et al.	431/170
5518697	May 1996	Dalla Betta et al.	422/173
5565009	October 1996	Ruhl et al.	48/197
5609834	March 1997	Hamada et al.	422/196
5811062	September 1998	Wegeng et al.	422/129
5858314	January 1999	Hsu et al.	422/211
6040266	March 2000	Fay et al.	502/439
6056932	May 2000	von Hippel et al.	423/376
6117578	September 2000	Lesieur	429/19
6159358	December 2000	Mulvaney et al.	208/46
6165633	December 2000	Negishi	429/17
6168765	January 2001	Romatier et al.	422/200
6180846	January 2001	Dandekar et al.	585/443
6190624	February 2001	Romatier	422/200
6193501	February 2001	Masel et al.	431/170
6200536	March 2001	Tonkovich et al.	422/177
6228341	May 2001	Hebert et al.	423/352
6241875	June 2001	Gough	208/106
6274101	August 2001	Sechrist	422/198
6488838	December 2002	Tonkovich et al.	208/108
6616909	September 2003	Tonkovich et al.	423/648.1
2002/0106596	August 2002	Hermann et al.	431/12
2002/0168308	November 2002	Loffler et al.	422/211

FOREIGN PATENT DOCUMENTS

FOREIGN-PAT-NO	PUBN-DATE	COUNTRY	CLASS

19841993	March 2000	DE
0848990	June 1998	EP
0885653	December 1998	EP
1031375	February 2000	EP
1123735	February 2001	EP
1123734	August 2001	EP
0869842	October 2001	EP
2353801	March 2001	GB
6111838	April 1994	JP
WO 96/32188	October 1996	WO
WO 00/06295	February 2000	WO
WO 01/10773	February 2001	WO
WO 01/12312	February 2001	WO
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WO 01/54806	August 2001	WO
WO 01/89681	November 2001	WO

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Mulder et al., "Catalytic Combustion in a Sintered Metal Reactor with Integrated Heat Exchanger," Applied Thermal Engineering, 825-836 (1997).
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Charlesworth, "Combustion and steam reforming of methane on thin layer catalysts for use in catlytic plate reactors," IMechE, 85-89 (1995).

ART-UNIT: 1754

PRIMARY-EXAMINER: Silverman; Stanley S.

ASSISTANT-EXAMINER: Medina; Maribel

ATTY-AGENT-FIRM: Rosenberg; Frank Harrington; Todd J.

ABSTRACT:

Integrated Combustion Reactors (ICRs) and methods of making ICRs are described in which combustion chambers (or channels) are in direct thermal contact to reaction chambers for an endothermic reaction. Superior results were achieved for combustion chambers which contained a gap for free flow through the chamber. Particular reactor designs are also described. Processes of conducting reactions in integrated combustion reactors are described and results presented. Some of these processes are characterized by unexpected and superior results.

30 Claims, 33 Drawing figures

☐ 7. Document ID: US 6902934 B1

L3: Entry 7 of 11 File: USPT Jun 7, 2005

US-PAT-NO: 6902934
DOCUMENT-IDENTIFIER: US 6902934 B1
** See image for Certificate of Correction **

TITLE: Methods for identifying optimizing catalysts in parallel-flow microreactors

DATE-ISSUED: June 7, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Bergh; H. Sam	San Francisco	CA		
Guan; Shenheng	San Jose	CA		

ASSIGNEE-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
Symyx Technologies, Inc.	Santa Clara	CA			02

APPL-NO: 09/728732 [PALM]
DATE FILED: November 28, 2000

PARENT-CASE:
This application is a divisional of Ser. No. 09/518,794, filed Mar. 3, 2000, now U.S. Pat. No. 6,749,814 which claims priority to commonly owned, co-pending U.S. patent application Ser. No. 60/122,704 filed Mar. 3, 1999 entitled "Chemical Processing Microsystems, Diffusion-Mixed Microreactors and Methods for Preparing and Using Same", which is hereby incorporated by reference for all purposes.

INT-CL: [07] G01 N 31/10

US-CL-ISSUED: 436/37; 422/130, 422/99, 422/100, 422/129
US-CL-CURRENT: 436/37; 422/100, 422/129, 422/130, 422/99

FIELD-OF-SEARCH: 422/99-104, 422/129-131, 436/43, 436/37

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

PAT-NO	ISSUE-DATE	PATENTEE-NAME	US-CL
3431077	March 1969	Danforth	23/253
3797202	March 1974	Neulander et al.	55/158
4099923	July 1978	Milberger	23/254
4386505	June 1983	Little	62/514R
4392362	July 1983	Little	62/514R
4516632	May 1985	Swift et al.	165/167
4537217	August 1985	Allen, Jr.	137/561A
4636315	January 1987	Allen, Jr.	210/656
4832914	May 1989	Tam et al.	422/130
4999102	March 1991	Cox et al.	210/137
5016707	May 1991	Nguyen	165/167
5089232	February 1992	May	422/83
5145579	September 1992	Eguchi et al.	210/198.2
5209906	May 1993	Watkins et al.	422/200
5230866	July 1993	Shartle et al.	422/103
5296375	March 1994	Kricka et al.	435/291
5296775	March 1994	Cronin et al.	310/309
5304354	April 1994	Finley et al.	422/196
5354460	October 1994	Kearney et al.	210/198.2
5356756	October 1994	Cavicchi et al.	430/315
5385712	January 1995	Sprunk	422/190
5388635	February 1995	Gruber et al.	165/80.4
5534328	July 1996	Ashmead et al.	428/166
5580523	December 1996	Bard	422/50
5587128	December 1996	Wilding et al.	422/50
5593642	January 1997	DeWitt et al.	422/131
5603351	February 1997	Cherukuri et al.	137/597
5611214	March 1997	Wegeng et al.	62/498
5639423	June 1997	Northrup et al.	122/50
5658413	August 1997	Kaltenbach et al.	156/272.8
5658537	August 1997	Dugan	422/191
5690763	November 1997	Ashmead et al.	156/60
5699157	December 1997	Parce	356/344
5776359	July 1998	Schultz et al.	252/62.51
5811062	September 1998	Wegeng et al.	422/129
5842787	December 1998	Kopf-Sill et al.	366/340
5843385	December 1998	Dugan	422/191
5846396	December 1998	Zanzucchi et al.	204/601
5852495	December 1998	Parce	356/344
5858195	January 1999	Ramsey	204/601
5869004	February 1999	Parce et al.	422/100
5872010	February 1999	Karger et al.	436/173
5908552	June 1999	Dittmann et al.	210/198.2
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5942443	August 1999	Parce et al.	436/514
5948227	September 1999	Dubrow	204/455
5955028	September 1999	Chow	422/63
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5965001	October 1999	Chow et al.	204/600
5965410	October 1999	Chow et al.	435/91.2
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6001229	December 1999	Ramsey	204/451
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6010608	January 2000	Ramsey	204/453
6042709	March 2000	Parce et al.	204/453
6042710	March 2000	Dubrow	204/454
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6100541	August 2000	Nagle et al.	250/573
6123798	September 2000	Gandhi et al.	156/292
6132685	October 2000	Kercso et al.	422/104
6190624	February 2001	Romatier	422/200
6319719	November 2001	Bhullar et al.	436/70
6333019	December 2001	Coppens	423/659
6409072	June 2002	Breuer et al.	228/111.5

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198 05 719	August 1999	DE	
198 06 848	August 1999	DE	
198 09 477	September 1999	DE	
0 870 541	October 1998	EP	
971 225	January 2000	EP	
0 870 541	November 2001	EP	
2 327 754	February 1999	GB	
WO 96/15576	May 1996	WO	
WO 96/35810	November 1996	WO	
WO 97/32208	September 1997	WO	
WO 98/07206	February 1998	WO	
WO 98/14268	April 1998	WO	
WO 98/16949	April 1998	WO	
WO 98/56956	December 1998	WO	

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WO 99/43432	September 1999	WO
WO 99/48599	September 1999	WO
WO 99/59716	November 1999	WO
WO 98/64160	December 1999	WO
WO 99/64836	December 1999	WO
WO 00/07026	February 2000	WO
WO 00/14529	March 2000	WO
WO 00/21666	April 2000	WO
WO 00/22424	April 2000	WO
WO 00/32308	June 2000	WO
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ART-UNIT: 1743

PRIMARY-EXAMINER: Alexander; Lyle A.

ABSTRACT:

A chemical processing microsystem useful for identifying and optimizing, materials (e.g., catalysts) that enhance chemical processes or for characterizing and/or optimizing chemical processes is disclosed. The chemical processing microsystem comprises a plurality of microreactors 600 and, in a preferred embodiment, a plurality of microseparators 900 integral with the chemical processing microsystem 10. The microreactors 600 are preferably diffusion-mixed microreactors formed in a plurality of laminae that include a modular, interchangeable candidate-material array 100. The material array 100 comprises a plurality of different candidate materials (e.g., catalysts), preferably arranged at separate, individually addressable portions of a substrate (e.g., wafer). The microseparators 900 are similarly formed in a plurality of laminae that include a modular, interchangeable adsorbent array 700.

54 Claims, 88 Drawing figures

☐ 8. Document ID: US 6890493 B1

L3: Entry 8 of 11 File: USPT May 10, 2005

US-PAT-NO: 6890493
DOCUMENT-IDENTIFIER: US 6890493 B1

TITLE: Methods and apparatus for fluid distribution in microfluidic systems

DATE-ISSUED: May 10, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Bergh; H. Sam	San Francisco	CA		
Guan; Shenheng	San Jose	CA		

ASSIGNEE-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
Symyx Technologies, Inc.	Santa Clara	CA			02

APPL-NO: 09/728263 [PALM]
DATE FILED: November 28, 2000

PARENT-CASE:
This application is a divisional application of co-pending U.S. patent application Ser. No. 09/518,794 filed Mar. 3, 2000, which itself claims priority to commonly owned, co-pending U.S. patent application Ser. No. 60/122,704 filed Mar. 3, 1999 entitled "Chemical Processing Microsystems, Diffusion-Mixed Microreactors and Methods for Preparing and Using Same", which is hereby incorporated by reference for all purposes.

INT-CL: [07] B01 J 19/00

US-CL-ISSUED: 422/130; 422/129, 422/99, 422/102, 436/52, 436/53, 436/180, 436/37, 137/884
US-CL-CURRENT: 422/130; 137/884, 422/102, 422/129, 422/99, 436/180, 436/37, 436/52, 436/53

FIELD-OF-SEARCH: 422/99-104, 422/129-131, 436/180, 436/52, 436/53, 436/37, 137/884

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

PAT-NO	ISSUE-DATE	PATENTEE-NAME	US-CL
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3797202	March 1974	Neulander et al.	55/158
3966420	June 1976	Pegels et al.	23/288R
4099923	July 1978	Milberger	23/254
4386505	June 1983	Little	62/514R
4392362	July 1983	Little	62/514R
4516632	May 1985	Swift et al.	165/167
4537217	August 1985	Allen, Jr.	137/561A
4636315	January 1987	Allen, Jr.	210/656
4820495	April 1989	Vu et al.	422/148
4832914	May 1989	Tam et al.	422/130
4921919	May 1990	Lin et al.	526/88
4999102	March 1991	Cox et al.	210/137
5016707	May 1991	Nguyen	165/167
5079205	January 1992	Canich	502/117

5089232	February 1992	May	422/83
5145579	September 1992	Eguchi et al.	210/198.2
5209906	May 1993	Watkins et al.	422/200
5230866	July 1993	Shartle et al.	422/103
5288644	February 1994	Beavis et al.	436/94
5296375	March 1994	Kricka et al.	435/2
5296775	March 1994	Cronin et al.	310/309
5304354	April 1994	Finley et al.	422/196
5354460	October 1994	Kearney et al.	210/198.2
5356756	October 1994	Cavicchi et al.	430/315
5385712	January 1995	Sprunk	422/190
5388635	February 1995	Gruber et al.	165/80.4
5498545	March 1996	Vestal	436/47
5534328	July 1996	Ashmead et al.	428/166
5580523	December 1996	Bard	422/50
5587128	December 1996	Wilding et al.	422/50
5593642	January 1997	DeWitt et al.	422/131
5603351	February 1997	Cherukuri et al.	137/597
5611214	March 1997	Wegeng et al.	62/498
5639423	June 1997	Northrup et al.	122/50
5658413	August 1997	Kaltenbach et al.	156/272.8
5658537	August 1997	Dugan	422/191
5690763	November 1997	Ashmead et al.	156/60
5699157	December 1997	Parce	356/344
5770860	June 1998	Franzen	250/288
5776359	July 1998	Schultz et al.	252/62.51
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5843385	December 1998	Dugan	422/191
5846396	December 1998	Zanzucchi et al.	204/601
5852495	December 1998	Parce	356/344
5858195	January 1999	Ramsey	204/601
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5872010	February 1999	Karger et al.	436/173
5908552	June 1999	Dittmann et al.	210/198.2
5935277	August 1999	Autenrieth et al.	48/127.9
5938333	August 1999	Kearney	366/336
5942443	August 1999	Parce et al.	436/514
5948227	September 1999	Dubrow	204/455
5955028	September 1999	Chow	422/63
5957579	September 1999	Kopf-Sill et al.	366/340
5959297	September 1999	Weinberg et al.	250/288
5965001	October 1999	Chow et al.	204/600
5965410	October 1999	Chow et al.	435/91.2
5976336	November 1999	Dubrow et al.	204/453
5989402	November 1999	Chow et al.	204/601
6001229	December 1999	Ramsey	204/451

6004515	December 1999	Parce et al.	422/100
6010607	January 2000	Ramsey	204/435
6010608	January 2000	Ramsey	204/453
6042709	March 2000	Parce et al.	204/453
6042710	March 2000	Dubrow	204/454
6046056	April 2000	Parce et al.	436/514
6068684	May 2000	Overton	96/104
6068752	May 2000	Dubrow et al.	204/604
6071478	June 2000	Chow	422/81
6074725	June 2000	Kennedy	428/188
6087180	July 2000	Gleaves	436/37
6087181	July 2000	Cong	436/37
6100541	August 2000	Nagle et al.	250/573
6103199	August 2000	Bjornson et al.	422/100
6123798	September 2000	Gandhi et al.	156/292
6132685	October 2000	Kercso et al.	422/104
6143152	November 2000	Simpson et al.	204/451
6149882	November 2000	Guan et al.	422/211
6221654	April 2001	Quake et al.	435/287.3
6287872	September 2001	Schurenberg et al.	436/181
6319719	November 2001	Bhullar et al.	436/70
6333019	December 2001	Coppens	423/659
6350617	February 2002	Hindsgaul et al.	436/173
6409072	June 2002	Breuer et al.	228/111.5
6426226	July 2002	Senkan	436/37
6485692	November 2002	Freitag et al.	422/130
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198 05 719	February 1998	DE	
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198 55 894	December 1998	DE	
198 09 477	September 1999	DE	
0 870 541	October 1998	EP	
971 225	January 2000	EP	
2 327 754	February 1999	GB	
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ART-UNIT: 1743

PRIMARY-EXAMINER: Warden; Jill

ASSISTANT-EXAMINER: Quan; Elizabeth

ABSTRACT:

A chemical processing microsystem useful for identifying and optimizing materials (e.g., catalysts) that enhance chemical processes or for characterizing and/or optimizing chemical processes is disclosed. The chemical processing microsystem comprises a plurality of microreactors 600 and, in a preferred embodiment, a plurality of microseparators 900 integral with the chemical processing microsystem 10. The microreactors 600 are preferably diffusion-mixed microreactors formed in a plurality of laminae that include a modular, interchangeable candidate-material array 100. The material array 100 comprises a plurality of different candidate materials (e.g., catalysts), preferably arranged at separate, individually addressable portions of a substrate (e.g., wafer). The microseparators 900 are similarly formed in a plurality of laminae that include a modular, interchangeable adsorbent array 700. The adsorbent array 700 comprises one or more adsorbents, preferably arranged at separate, individually addressable portions of a substrate to spatially correspond to the plurality of different candidate materials. Modular microfluidic distribution systems are also disclosed. The chemical processing microsystem can be integrated into a material evaluation system that enables a comprehensive combinatorial material science research program.

15 Claims, 72 Drawing figures

☐ 9. Document ID: US 6749814 B1

L3: Entry 9 of 11 File: USPT Jun 15, 2004

US-PAT-NO: 6749814
DOCUMENT-IDENTIFIER: US 6749814 B1

** See image for Certificate of Correction **

TITLE: Chemical processing microsystems comprising parallel flow microreactors and methods for using same

DATE-ISSUED: June 15, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Bergh; H. Sam	San Francisco	CA		
Guan; Shenheng	San Jose	CA		

ASSIGNEE-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
Symyx Technologies, Inc.	Santa Clara	CA			02

APPL-NO: 09/518794 [PALM]
DATE FILED: March 3, 2000

PARENT-CASE:
This application claims priority to commonly owned, co-pending U.S. patent application Ser. No. 60/122,704 filed Mar. 3, 1999 entitled "Chemical Processing Microsystems, Diffusion-Mixed Microreactors and Methods for Preparing and Using same", which is hereby incorporated by reference for all purposes.

INT-CL: [07] B01 J 19/00, G01 N 31/00

US-CL-ISSUED: 422/130; 422/99, 422/100, 422/102, 422/129, 436/37
US-CL-CURRENT: 422/130; 422/100, 422/102, 422/129, 422/99, 436/37

FIELD-OF-SEARCH: 422/99-104, 422/129-131

PRIOR-ART-DISCLOSED:

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4386505	June 1983	Little	62/514R
4392362	July 1983	Little	62/514R
4516632	May 1985	Swift et al.	165/167
4537217	August 1985	Allen, Jr.	137/561
4636315	January 1987	Allen, Jr.	210/656
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6074725	June 2000	Kennedy	428/188
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ART-UNIT: 1743

PRIMARY-EXAMINER: Warden; Jill

ASSISTANT-EXAMINER: Quan; Elizabeth

ABSTRACT:

A chemical processing microsystem useful for identifying and optimizing materials (e.g., catalysts) that enhance chemical processes or for characterizing and/or optimizing chemical processes is disclosed. The chemical processing microsystem comprises a plurality of microreactors 600 and, in a preferred embodiment, a plurality of microseparators 900 integral with the chemical processing microsystem 10. The microreactors 600 are preferably diffusion-mixed microreactors formed in a plurality of laminae that include a modular, interchangeable candidate-material array 100. The material array 100 comprises a plurality of different candidate materials (e.g., catalysts), preferably arranged at separate, individually addressable portions of a substrate (e.g., wafer). The microseparators 900 are similarly formed in a plurality of laminae that include a modular, interchangeable adsorbent array 700. The adsorbent array 700 comprises one or more adsorbents, preferably arranged at separate, individually, addressable portions of a substrate to spatially correspond to the plurality of different candidate materials. Modular microfluidic distribution systems are also disclosed. The chemical processing microsystem can be integrated into a material evaluation system that enables a comprehensive combinatorial material science research program.

142 Claims, 88 Drawing figures

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KMC | Draw

☐ 10. Document ID: US 6737026 B1

L3: Entry 10 of 11 File: USPT May 18, 2004

US-PAT-NO: 6737026
DOCUMENT-IDENTIFIER: US 6737026 B1
** See image for Certificate of Correction **

TITLE: Methods for identifying and optimizing materials in microfluidic systems

DATE-ISSUED: May 18, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Bergh; H. Sam	San Francisco	CA		
Guan; Shenheng	San Jose	CA		

ASSIGNEE-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
Symyx Technologies, Inc.	Santa Clara	CA			02

APPL-NO: 09/728209 [PALM]
DATE FILED: November 28, 2000

PARENT-CASE:
This application claims is a divisional application of copending U.S. patent application Ser. No. 09/518,794 filed Mar. 3, 2000, which itself priority to commonly owned, co-pending U.S. patent application Ser. No. 60/122,704 filed Mar. 3, 1999 entitled "Chemical Processing Microsystems, Diffusion-Mixed Microreactors and Methods for Preparing and Using Same", which is hereby incorporated by reference for all purposes.

INT-CL: [07] B01 J 19/00, G01 N 31/10

US-CL-ISSUED: 422/130; 422/129, 422/99, 422/102, 422/100, 436/37
US-CL-CURRENT: 422/130; 422/100; 422/102, 422/129, 422/99, 436/37

FIELD-OF-SEARCH: 422/99-104, 422/129-131, 436/37

PRIOR-ART-DISCLOSED:

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5580523	December 1996	Bard	422/50
5587128	December 1996	Wilding et al.	422/50
5593642	January 1997	DeWitt et al.	422/131
5603351	February 1997	Cherukuri et al.	137/597
5611214	March 1997	Wegeng et al.	62/498
5639423	June 1997	Northrup et al.	122/50
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5690763	November 1997	Ashmead et al.	156/60
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5852495	December 1998	Parce	356/344
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5869004	February 1999	Parce et al.	422/100
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5965410	October 1999	Chow et al.	435/91.2
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ART-UNIT: 1743

PRIMARY-EXAMINER: Warden; Jill

ASSISTANT-EXAMINER: Quan; Elizabeth

ABSTRACT:

A chemical processing microsystem useful for identifying and optimizing materials (e.g., catalysts) that enhance chemical processes or for characterizing and/or optimizing chemical processes is disclosed. The chemical processing microsystem comprises a plurality of microreactors 600 and, in a preferred embodiment, a plurality of microseparators 900 integral with the chemical processing microsystem 10. The microreactors 600 are preferably diffusion-mixed microreactors formed in a plurality of laminae that include a modular, interchangeable candidate-material array 100. The material array 100 comprises a plurality of different candidate materials (e.g., catalysts), preferably arranged at separate, individually addressable portions of a substrate (e.g., wafer). The microseparators 900 are similarly formed in a plurality of laminae that include a modular, interchangeable adsorbent array 700. The adsorbent array 700 comprises one or more adsorbents, preferably arranged at separate, individually addressable portions of a substrate to spatially correspond to the plurality of different candidate materials. Modular microfluidic distribution systems are also disclosed. The chemical processing microsystem can be integrated into a material evaluation system that enables a comprehensive combinatorial material science research program.

24 Claims, 88 Drawing figures

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw D...

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L3: Entry 11 of 11 File: USPT Jan 20, 2004

US-PAT-NO: 6680044
DOCUMENT-IDENTIFIER: US 6680044 B1

TITLE: Method for gas phase reactant catalytic reactions

DATE-ISSUED: January 20, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
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APPL-NO: 09/640903 [PALM]
DATE FILED: August 16, 2000

PARENT-CASE:
RELATED APPLICATIONS This application is a Continuation-In-Part of U.S. patent application Ser. No. 09/375,614, now U.S. Pat. No. 6,488,838, filed Aug. 17, 1999, which is incorporated herein in full, as if reproduced below.

INT-CL: [07] C01 B 3/26

US-CL-ISSUED: 423/652; 423/418.2, 423/437.2, 252/373
US-CL-CURRENT: 423/652; 252/373, 423/418.2, 423/437.2

FIELD-OF-SEARCH: 208/108, 208/143, 208/209, 252/373, 423/418.2, 423/437.2, 423/648.1, 423/651, 423/652, 423/656, 423/659, 568/924, 570/101, 570/123, 585/250, 585/654, 431/7

PRIOR-ART-DISCLOSED:

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ART-UNIT: 1754

PRIMARY-EXAMINER: Silverman; Stanley S.

ASSISTANT-EXAMINER: Medina; Maribel

ATTY-AGENT-FIRM: May; Stephen R. Rosenberg; Frank S.

ABSTRACT:

The present invention provides chemical reactors and reaction chambers and methods for conducting catalytic chemical reactions having gas phase reactants. In preferred embodiments, these reaction chambers and methods include at least one porous catalyst material that has pore sizes large enough to permit molecular diffusion within the porous catalyst material.

92 Claims, 28 Drawing figures

Term	Documents
HEAT	3423803
HEATS	129036
EXCHANGER$1	0
EXCHANGER	325980
EXCHANGERA	11
EXCHANGERB	2
EXCHANGERC	1
EXCHANGERE	14
EXCHANGERF	2
EXCHANGERG	23
EXCHANGERI	35
(L2 AND HEAT EXCHANGER$1).PGPB,USPT,USOC,EPAB,JPAB,DWPI.	11

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